# Geologic Characterization
# of the
# Proposed Poorman Tailing Repository

## Introduction

Because of its complex geologic setting, a geologic characterization of the proposed Poorman Repository location was necessary to assess its suitability as a mine tailing repository. Specific objectives of this effort were to understand the local stratigraphy, its lateral continuity, local geologic structures such as faulting, and its surface soils.

This characterization effort consisted of the backhoe excavation and logging of seven soil observation pits from which the soil profiles were recorded for texture, horizon thickness and overall soil morphology. A surface geophysical survey, utilizing two-dimensional electrical resistivity technology, was implemented to image spatial variations and thickness of overburden. Though intrusive techniques typically provide very accurate data, e.g., drill core or tangible hand samples, its information is limited in a lateral extent. Two-dimensional resistivity data, however, offers relatively laterally continuous data which often provides a more comprehensive understanding of subsurface conditions. Taking advantage of all these positive attributes, this characterization effort combined the two approaches to obtain the best results of the near-surface conditions. This effort was initiated in November 2002 by the Bureau of Land Management (BLM).

## Methodology

<u>Soil Observation Pits</u>

The objectives of the soil pits were to determine suitability of local soils for the repository cover, and its rippability for excavation of the repository footprint. These specific objectives are discussed in geotechnical section of this report. Additional objectives were to record the site's soil morphology such as texture, horizon thickness, and lateral extent. This information is further used to assess the land form processes active at the site and to augmented interpretations of hill slope stability.

Seven soil observation pits were excavated using a backhoe and soil profiles were recorded and photographed **(Plate 1).** Standard soil-horizon nomenclature for major horizons was used for the descriptions (Birkeland, 1999). The need for formal soil taxonomic classification was not necessary, because it is the physical soil condition rather than the soil's order or suborder which has direct bearing on the suitability of the site as a repository. A Munsell color chart (1994 edition) was used to record soil color. Depths and overall horizon thickness were recorded to the nearest centimeter, and soil texture was recorded in the field. Additional soil characteristics such as clay films, clay coats and clay bridges were also recorded.

Direct Current Electrical Resistivity Methodology

The resistivity of any material is defined as its electrical resistance in ohms across a known volume of that material, or in other words, the ability of the material to inhibit an electrical current which is the reciprocal of electrical conductivity. An electrical resistivity survey is used to determine depths and distance to geologic interfaces which are analogous to a series of electrical resistors. The specific resistivity method utilized in this survey acquired two-dimensional data in order to delineate the spatial distribution and thickness/depths of these resistors. Though the magnitude of resistivity is important, often it is the information obtained from the lateral and/or vertical changes, i.e., spatial distribution, of the data that is more diagnostic. Inferences from spatial variations of resistivity are made of the distribution of the subsurface stratigraphy and sediment facies. It is up to the user, however, to ascertain the cause of the changes in the data. Therefore, it is important to develop a conceptual model of the geologic setting and the effects it may have on the geophysical signature. Such a model is important at this site, because of the possible isolated bodies of basalt, and the complex accreted geologic environment.

Electrical resistivity surveys can be employed in various electrode arrangements (arrays), though the basic resistivity principals are the same for all array types. For this survey, a schlumberger array was used. In simple terms, this linear array involves the application of an electrical current to the ground via two source electrodes. The potential difference created at the surface is measured between two receiving electrodes, located at a known distance. The potential difference (voltage drop) produced by the current, as it encounters earthen materials (resistors), is measured and used to determine the resistivity of the material encountered. The effective depth of a measurement is sequentially increased by increasing the distance between electrode pairs. The further this distance, the greater the vertical interval (depth) in which the bulk of the current flows. As the electrode separation is incrementally changed, differences or contrasts of resistivity are notable when changes in the geo-electrical properties are encountered. These changes are inferred as geologic boundaries caused by changes in lithology, sediment grain-size, moisture and/or chemical boundaries due to changes in water chemistry. For this site, these changes could be caused by the presence of the clayey soil profiles, variations in weathered bedrock, dipping greenstone, and basalt layers. Because the electrical current will prefer to flow in areas of low resistivity, such as clay or salts, the resistivity value will be a relatively lower magnitude as compared to sand, gravel, and basalt. The apparent resistivity value is recorded by the instrument and is measured in ohm-m.

The sequential changes in electrode arrangement were performed automatically by specialized equipment. For this study, an automated multielectrode system was employed which consisted of a Sting R1 resistivity meter and the Swift automatic switching box and multielectrode cable; all are manufactured by Advanced Geosciences Inc. in Austin, Texas **(Attachment Cover Page).** The specific equipment utilized in this survey was limited to 60 electrodes, and each separated by 5-meters of cable. The effective depth of the investigation was limited to the 60 electrodes and their maximum separation of 4m to provide the greatest depth of the survey. However, the lateral coverage of a survey line could be increased by leapfrogging segments of cable in the direction of the survey. This "roll-along" technique was used on lines PM-2 and PM-3. For greater resolution an electrode separation of 1-meter was used, however, at the sacrifice of achieving greater depths.

Data Acquisition

The resistivity data were collected in a two-dimension fashion using either a 1-meter or 4-meter electrode spacing. For quality assurance, the resistivity instrumentation was programmed to collect a single data point twice. If the two values were within 2% of each other, the data point was recorded, otherwise, the data point was skipped. A few data points were skipped at the beginning of line PM-3, however, resistivity boundaries could be viewed across the skipped portion of the data profile. These skips rarely impact the final inverted profile, because of the smoothing algorithm used in the processing software (see Data Analysis below).

Each resistivity line was mapped using global positioning system (GPS) instrumentation (Trimble Geoexplorer) with the accuracy less than1 meter. The perimeter of the proposed repository was also mapped with GPS.

Data Analysis

Interpretations made from unprocessed resistivity field data (pseudosections) can be tricky, and more accurate interpretation methods rely upon computer processing generally known as data inversion. The inversion process basically accounts for the geometry of the electrodes, voltage etc. and suggests the "true resistivity" rather than the apparent resistivity presented in the pseudosection. Inversion can be further controlled with correlations to drill logs or outcrops. If no control is available, the inversion process can still be used, and in either case, a "best fit model" is generated. Again, in all cases, it is up to the user to determine if the processed data profile is possible given the existing knowledge of site conditions (site model). All survey lines were inverted and plotted in the field so real-time modifications to survey strategies, if necessary, would be possible. Though soil pit information was obtained, their results weren't utilized to control the inversion processing because acceptable correlations were possible without their addition.

The resistivity data obtained during this survey were inverted using a smoothing algorithm provided in processing software licenced to the BLM. This software is Interpex Software (IP2DI version 4.12) of Golden, Colorado.

The geophysical survey consisted of three electrical resistivity survey lines which transected the site at various orientations **(Plate 2)**.

## Results and Discussions

Soils Profiles

Detailed descriptions of the soil profiles are provided in the attached summary sheets. Soils of the repository site closely match those of the Keating series. Soils of the Keating series have developed in an upland areas on residuum from weathered greenstone bedrock (SCS, 1954, SCS 1997, USDA website http://soils.usda.gov/). The terrain is gently to steeply sloped and vegetated by sagebrush and grass. Though the SCS information suggests the Keating's A horizon is more extensive (0 to 20cm) than what is found in this investigation (0 to 9cm), several of the Keating subcategories (phases) may account for the thinner A horizon by the added erosional processes occurring on hillsides. Overall the A horizon of the site is thin 0 to 9 cm and is a silty loam. The B horizon is complex and transitions from the A horizon with increases in clay content of approximately 15% to 20%. This horizon is considered a B horizon because of the increased clay content and the clay films noted on sand grains and ped surfaces. Further indication of a thinner A horizon was the observation of slight increases in calcium carbonate, forming a thin juvenile caliche horizon (Bk horizon) just beneath the A horizon. This Bk horizon was only found in pits #1, 2 and 4, This horizon was not easily noticed in the profiles, but can be seen in the photograph of the Pit #1 hand samples on Plate 1.

With increasing depth, clay content of the B horizon increases to nearly 50%. Such an increase, relative to the overlying unit, is classified as argillic and known as a Bt horizon. In the field, this unit is typically recognizable by its redder hues and waxy appearance on ped surfaces. The Bt horizon continues in depth to the top of saprolite, e.g., weathered bedrock. Though clay coating of sand grains and clay bridges between grains occur in the B horizon, the clay content of the Bt was great enough to cause a waxy appearance to the peds surfaces. This clay extends (25 to 60 cm) into the underlying bedrock which is abundantly fractured with very fine, hair-line fractures to the degree that it is easily crushable by hand. Because of the recognizable bedrock laminations and bedding structures, this interval could not be considered part of the Bt horizon, but rather the Cr horizon, a saprolite, e.g., weathered bedrock. In some cases heavy clay coating on the basalt bedrock warranted the designation of Crt, suggesting a continuation of the clay "t" downward into the bedrock.

The complexity of the B and Bt horizons is greatly influenced by the hillslope, depth to bedrock, and type of bedrock. Of particular importance is the increasing amount of pedogenic clay, particularly its accumulation towards the toe of the hill. A variety of geomorphologic, pedological, and hydrological forces cause soils on a hillslope to bear distinct relationship to the soils upslope, and downslope (Birkeland, 1999). This is largely due to the watershed topography, where net soil loss occurs in the steeper upslope areas, and net gains occur in the downslope. This general soil setting is referred to as a catena. This general thinning of the A and sometimes B horizons is found to occur on the soil profiles of the site **(Plate 1)**. Given the consistent soil profiles of this catena, soil development is considered to be occurring under normal processes and no tectonic influences were observed which would have disrupted the catena sequence.

Though there are some variations from the Keating series, particularly the thickness of the A horizon, the interpretation value of the soil descriptions acquired by this study satisfy the objectives in the same manner as the Keating series.

Maximum excavation depths of the soil pits coincided with the softness of the saprolite; 6ft (Pit #1), 7ft (Pit #2), 12ft (Pit #3), 5.5ft (Pit #4), 4.5ft (Pit #5), 10ft (Pit #6, and 11ft (Pit #7). Generally speaking, excavation depths increase eastward across the site as the occurrence of basalt diminishes. Vegetation roots were found to exist in the upper A and B horizons, while only a few larger roots were found to penetrate the Cr horizon.

Electrical Resistivity

The broad spectrum of objectives for the surface geophysical survey required modifications to the electrode spacings. The objectives of identifying deeper bedrock structures such as faulting, and/or large fracture zones required a 4-meter spacing for line PM-1. Additional objectives, requiring shallower, high resolution data, were those of determining the depth to bedrock, and the overall saprolite thickness. The shallow high resolution lines (PM-2 and PM-3) utilized a 1-meter electrode spacing. Bedrock information obtained from the soil pits further augmented the results of the two high resolution resistivity lines, and provide better understanding of lateral characteristics of the bedrock across the site. Locations of the three resistivity lines are provided in **Plate 2.**

Line PM-1 *(schlumberger array, 4m electrode spacing using 60 electrode)*

The objective of this line was to characterize the structural setting by imaging greater depths. Using the available 60 electrodes, each separated by 4m, the maximum depth of approximately 60m (192 ft) was achieved. The line traverses the site from southwest to northeast **(Plate 2).**

The lowest resistivity of this profile (30 to 80 ohm-m) forms the uppermost layer and crosses the entire profile, e.g., the site. This layer extends from ground surface to a maximum depth of 9.5m (30 ft). The thickness of this layer, however, varies to as little as 8m (25ft) due to influence of an elongate lens of much greater resistivity (2,000 to 9,800 ohm-m) found between electrodes #18 and #48. Based upon its lenticular shape and magnitude of resistivity, this anomaly is likely that of a buried basalt or gravel. Resistivity of the surrounding bedrock ranges from 140 to 200 ohm-m. Faulting or large fracture patterns are not observed on this profile.

It is important to understand the electrical field generated during a resistivity measurement is 3-dimensional, resembling a subsurface half-pipe along the linear array, and thereby detecting resistivity properties laterally as well as vertically beneath an array cable. The larger the electrode spacing, the greater this lateral effect. This often becomes an important factor when comparing lines of varying electrode spacing, e.g., resolution, and is discussed further in the following.

Line PM-2 *(schlumberger array, 1m electrode spacing using 60 electrodes with three 20 electrode roll-alongs)*

The objective of this line was to image the shallow stratigraphy for lateral consistency, fracturing, and saprolite thickness. This line transects, from west to east, along the site's northern portion. Three roll-alongs were used to extend the line across the site. Its entire length was 120 meters and its approximate maximum image depth was less than 15m (48ft), which intersects the upper portion, e.g., depth, of the basalt anomaly found in PM-1.

The uppermost layer found on this profile is of the lowest resistivity (15 to 90 ohm-m) and appears to extends across the entire site. However, between electrodes #34 and #58, an increase in resistivity (80 to 200 ohm-m) occurs. This change is coincident to a lenticular body of significantly greater resistivity (1,000 to 10,000 ohm-m) found on this profile. This body is likely that of a basalt flow, and its contributions to the overlying soil profile, with added coarse-grained sediment has increased its resistivity. The base of this basalt flow is abrupt and flat, occurring at 5m (16ft). The top, however, may be as shallow as 2.7m (8.6ft) beneath electrode #40. Soil Pit #5 is located approximately 13m north of electrode #40, and its excavated depth was limited to 5ft, the shallowest of the study due to a more competent clayey bedrock. Basalt boulders were found in this pit which validate the presence of basalt and the facies change noted on the resistivity profile. The thickness of this layer of low resistivity reaches a maximum of 4.3m (13ft) near electrodes #75. Soil Pit #3 is located approximately 10m north of electrode #75. The excavation depth of this pit was 3.7m (12ft), the deepest in this study. Bedrock observed in this pit was greenstone and is striking approximately NE and dipping steeply, approximately 60 degrees NW. Depth to the bedrock in this pit was variable, due scouring by colluvial deposition, and ranged from 60cm (24 inches) to 85cm (33inches). This greenstone bedrock is easily crushed by hand into sand and granule-sized grains. The low resistivity (15 to 90 ohm-m) corresponds to this highly weathered greenstone and surface soils. The thickness of this upper layer of low resistivity increases eastward across the site as the occurrence of basalt decreases; 2.7m (8.6ft) to 5m (16ft) on the eastern side.

A layer of moderate resistivity (250 to 650 ohm-m) crosses the profile directly beneath and parallel to the lenticular basalt previously discussed, however, this layer is thicker (3.6m to 9m) and laterally more extensive. Because this layer is discordant to the local bedrock, it's of a younger age. A thin interbed, separating the overlying lenticular basalt from this layer occurs between electrode #81 and #93. Without additional information the exact nature of this deposit can not be determined, however, it is likely an older basalt flow, or a fluvial deposit. Its lower contact with the surrounding bedrock is gradational which may indicate fluvial deposition. Bedrock beneath these unconformable units is of low resistivity (120 to 170 ohm-m).

Line PM-3 *(schlumberger array, 1m electrode spacing)*

The objective of this line is identical to PM-2, to image the shallow stratigraphy for lateral consistency, fracturing, and saprolite thickness. This line transects the site from southwest to northeast, subparallel to line PM-1, and falls approximately 20m short of intersecting PM-2. The first electrode of PM-3 corresponds approximately to electrode #16 of PM-1. Two roll-alongs, both consisting of 20 electrodes segments, were utilized to extend the total length to 100m. Its maximum image depth was no greater than 15m.

As found on the previous resistivity lines, the surface interval was the lowest in resistivity (12 to 80 ohm-m), and crosses the profile until encountering a facies change at electrode #70. This facies change is likely the same identified in line PM-2, but occurs over a lenticular body of lower resistivity (160 to 390 ohm-m) than that found on line PM-2. The lenticular bodies of the greater resistivity are also found, and with similar resistivity values as those found on line PM-2 (500 to 6,000 ohm-m). The base of this lenticular body is also abrupt and flat, occurring at 5m, the same as found on line PM-2. Underlying the lenticular basalt is the thicker bed of moderate resistivity (140 to 300 ohm-m). The lower contact of this moderate layer is gradation with the underlying bedrock. This gradation contact is present on line PM-2, though not as pronounced. A gradational contact better represents a fluvial deposit than the morphology of an older basalt flow, however, the only conclusion that can be made is that the sediments of this interval are relatively coarse-grained as indicated by the moderate values of resistivity.

Soil Pit #1 is located approximately 15m west of electrode #6, and was excavated to a depth of 1.8m (6ft). Bedrock in this pit as extremely clayey which corresponds to the low resistivity of the upper layer. Located approximately 5m east of electrode #60 is Pit #2. Variations in the amount of clay are apparent in the photograph on **Plate 1**. The variations in clay will cause a variation of resistivity, and may be the facies changes previously discussed.

## Conclusions

Soils of the site resemble the Keating series which is a thin clayey soil over weathered greenstone. Excavation depths of the seven soil pits varied, and were greatest (10 to 12ft) when encountering greenstone bedrock. Weathered basalt was encountered in several of the pits, and limited the excavation depths to 5 to 6ft.

The uppermost layer of the site is composed of a layer of low electrical resistivity which increases in thickness (12ft) over areas of subcropping greenstone, and is thinner in area of basalt which occur on the western side of the site. This layer represents the saprolite, e.g., weathered bedrock, and should be relatively easier to excavate.

Based upon soil morphology and electrical resistivity data, the hill side and geologic setting of the proposed repository location is structurally stable and considered suitable for construction of a tailing repository.

## References

Birkeland, Peter, 1999. Soils and Geomorphology, third edition, Oxford University Press.

SCS, 1954. Soil Conservation Service, Soil Survey of the Baker Area Oregon, series 1941, No.9.

SCS, 1997. Soil Conservation Service, Soil Survey of Baker County Area, Oregon, survey OR647.
www.or.nrcs.usda.gov/soil/mo/mo_reports_or.htm

**Soil Profile Summary Sheets**

**Pit #1**
Location: Easting: 461845.074 Northing: 4973407.209

Excavation was relativley easy in upper 3ft, then became more difficult in the weathered clayey, bedrock.
Slope: Concave

A-- 0 to 5 cm; dark gray (7.5YR 4/2), silty loam,
weak fine granular structure; soft, friable,
slightly sticky when wet, and plastic;
many fine roots; abrupt boundary with B Horizon.

Bk-- 5 to 13cm; gray brown (7.5YR 6/2),
soft small to large subangular blocky structure,
few well round rock fragments; fine roots, sticky and plastic
when wet, approx 15% clay; this horizon was only
only noticeable in hand sample.

B-- 13 to 26cm; brown (7.5YR 4/4); clay loam, ~50% clay;
soft fine to medium subangular blocky structure; clay films on grains;
many fine roots, sticky and plastic when wet;
fewer roots, some larger roots; wavey to smooth boundary.

Bt-- 26 to 60cm; (7.5YR 3/4); clay loam, over 60% clay,
medium to coarse blocky structure, strong clay films, waxy appearance;
sticky and plastic when wet; fine roots, few large roots;
irregular boundary with underlying Cr.

Cr-- 60 to TD (182cm); (2.5Y 5/6), Clay,
massive structure, increasing rock fragments with depth;
weathered greenstone.

**Pit #2**
Location: Easting: 461887.680    Northing: 4973439.636

Excavation depth was 7ft.
Slope: Concave

A-- 0 to 4cm; brown (7.5YR 4/2), silty loam,
weak fine granular structure; soft, friable,
slightly sticky when wet, and plastic;
many fine roots; boundary with Bk horizon is weak;

Bk-- 5 to 8cm; (7.5YR 6/2), silty loam,
soft small to large subangular blocky structure,
few well round rock fragments; fine roots, sticky and plastic
when wet, approx 15% clay; this horizon was only
only noticeable in hand sample.

B-- 8 to 40cm; (7.5YR 4/2), clay loam,
soft fine to medium subangular blocky structure;
many fine roots, sticky and plastic when wet; clay films on grains and surfaces;
fine roots, some larger roots; wavey to smooth boundary.

Bt-- 40 to 70cm; (7.5YR 3/4); clay loam, over 60% clay,
medium to coarse blocky structure, strong clay films, waxy appearance;
sticky and plastic when wet; fine roots, few large roots;
irregular boundary with underlying Cr.

Cr-- 80 to TD (213cm); mottled tan 5YR3/2, and orange 5Y 5/3
clay and friable weathered greenstone.

**Pit #3**
Location: Easting: 461936.185 Northing: 4973472.632

Excavation depth was 12ft. Relatively easy in upper 4ft, and became slightly more difficult in lower 8ft.
Slope: Concave
This was a complex profile with colluvial fill and irregular saprolite contact.

A-- 0 to 7cm; brown (7.5YR 3/2), silty loam,
weak fine granular structure; soft, friable,
slightly sticky when wet, and plastic; few small to large subangular
basalt rock fragments; many fine roots;
boundary with Bk horizon is weak;

Bk-- 7 to 9cm; (7.5YR 6/2), silty loam,
soft small to large subangular blocky structure;
fine roots, sticky and plastic when wet, basalt rock fragments;
this horizon was only noticeable in hand sample and difficult to find in profile.

B-- 9 to 40cm; (7.5YR 4/2), clay loam,
soft fine to medium subangular blocky structure, ~30% clay;
sticky and plastic when wet; clay films on grains and surfaces;
many fine roots, some larger roots; basalt rock fragments some cobble-size,
weathers red with clay coats, colluvial basalt rock (?) on weathered greenstone;
wavy boundary.

Bt-- 40 to 60cm; (5YR 3/3); clay loam, over 60% clay,
medium to coarse blocky structure, strong clay films, waxy appearance;
sticky and plastic when wet; fine roots, few large roots;
irregular boundary with underlying Cr.

Crt – 60 to 80; reddish yellow (7.5 YR 6/6 ) and reddish brown (5YR 4/3);
can be as shallow as 25cm; highly weathered, foliated bedrock,
striking NS and dipping steeply 70 degree northwest;
wavy irregular contact with yellow weathered bedrock.

Cr-- 80 to TD (213cm); surface strong brown 7.5YR 5/6, crushes with hand to sand and granule-size;
clay and friable weathered greenstone.

Note: The depth to Cr was variable; ranging from 20cm to 85cm with strong clay films on soft weathered greenstone, small to large colluvial basalt rocks in upper 85cm weather red. Bedrock is striking NE and dipping steeply west 70 degrees.

**Pit #4**
Location:
Easting:  461893.757   Northing: 4973477.111

Excavation was limited to167cm (5.5 ft) by weathered basalt bedrock. Upper 3ft was easy to excavate.
Slope: Concave

A-- 0 to 8cm; brown (7.5YR 3/2), silty loam,
weak fine granular structure; soft, friable,
slightly sticky when wet, and plastic; few subangular basalt rock fragments,
many fine roots; smooth boundary

B-- 8 to 22cm; (7.5YR 4/2), clay loam,
soft fine to medium subangular blocky structure, ~30% clay;
many fine roots, sticky and plastic when wet; clay films on grains and surfaces;
fine roots, some larger roots; subangular basalt rock fragments some cobble-size;
smooth boundary.

Bt-- 22 to 40cm; (7.5YR 4/2); clay loam, over 60% clay,
medium to coarse blocky structure, strong clay films, waxy appearance;
sticky and plastic when wet; fine roots, few large roots;
irregular boundary with underlying Cr.

Crt-- 40 to 75cm; (5YR3/4); weathered basalt (?), bedding is not present,
soft friable; clay coating aggregates, wavy irregular boundary.

Cr -- 70cm to TD (167cm, 5.5ft); Basalt bedrock (?) weathers to yellow clay.

**Pit #5**
Location: Easting: 461917.780 Northing: 4973497.925

Excavation was terminated at 5ft due to difficult digging. Upper 3ft relatively easier digging.
Slope: Concave

A-- 0 to 4cm, (7.5YR 6/2), silty loam,
soft, friable, granular to small subangular blocky structure;
sticky and plastic when wet, fine roots, basalt rock fragments;

Bt-- 4 to 30cm, (7.5YR 4/3); clay loam; small subangular blocky structure;
slightly sticky and plastic waxy appearance, weak clay films; gradational boundary.

Bt2-- 30 to 60cm; brown (7.5YR 4/2) to reddish brown (5YR 4/3);
clay loam, over 60% clay; medium to coarse blocky structure, strong clay films,
waxy appearance; sticky and plastic when wet; fine roots, few large roots;
irregular boundary with underlying Cr.

Crt- - 60 to TD (144cm, 5ft); red heavy clay coating on weathered friable basalt.

**Pit #6**
Location  Easting: 461924.020  Northing: 4973426.478

Excavation was easy in upper 3ft, then encountered variable hardness from 3 to 5 ft, before becoming easier to 10ft.
Slope: Concave

A-- 0 to 4cm, brown (7.5YR 4/2), silty loam,
weak fine granular structure; soft, friable,
slightly sticky when wet, and plastic;
many fine roots.

BA-- 4 to 20cm; brown (7.5YR 5/2 ), clay loam; fine to moderate
subangular blocky structure; rounded pebbles some angular; many fine roots;
smooth boundary.

B-- 20 to 30cm; brown (7.5YR 4/3), clay loam;
soft fine to medium subangular blocky structure;
many fine roots, sticky and plastic when wet; clay films on grains and surfaces;
fine roots, some larger roots; wavy to smooth boundary.

Bt-- 30 to 80; (7.5YR 4/2); clay loam
medium to coarse blocky structure, strong clay films, waxy appearance;
sticky and plastic when wet; fine roots, few large roots;
irregular boundary with underlying Cr.

Cr  80 to TD (10ft); yellowish brown 10YR 5/6; clayey weathered greenstone bedrock;

**Pit #7**
Location : Easting  461961.248   Northing:  4973412.601

Excavation was relatively easy to 5ft, then became difficult.
Slope: Concave

A-- 0 to 4cm;, brown (7.5YR 4/2), silty loam,
weak fine granular structure; soft, friable,
slightly sticky when wet, and plastic;
many fine roots.

BA-- 4 to 27cm; brown (7.5YR 5/2 ), clay loam;

Bt-- 27 to 67cm;  (7.5YR 4/2); clay loam
medium to coarse blocky structure, strong clay films, waxy appearance;
sticky and plastic when wet; fewer fine roots, few large roots; wavy boundary;
irregular boundary with underlying Cr.

Cr– 67 to TD (11ft); clayey yellowish weathered bedrock,
likely weathered greenstone.